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PATENT ABSTRACTS OF JAPAN

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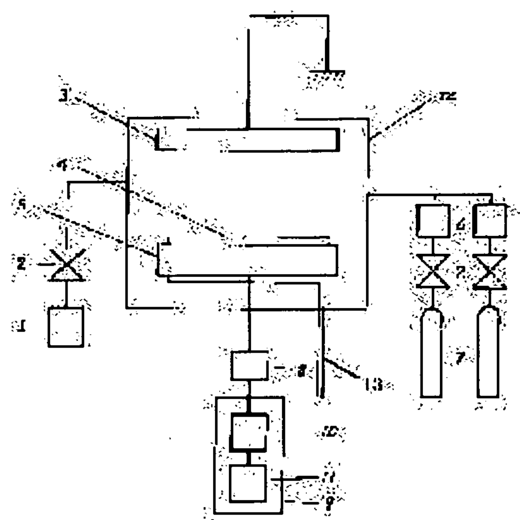
(71)Applicant : NISSIN ELECTRIC CO LTD
(72)Inventor : SAKAMOTO HIROMICHI
NAKAHIGASHI TAKAHIRO
KUWABARA SO

(54) PLASMA TREATMENT IN PRECEDING PROCESS FOR SOLDER BONDING TREAMENTG AND DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To remove a metallic oxide on the solder bonded surface of a substrate to be treated and the dirt on the solder bonded surface in a short time by a method wherein high-frequency power subjected to first pulse modulation of 1/100000 or higher to 1/10 or lower of a prescribed frequency of a specified value or higher is applied to high-frequency power of this prescribed frequency of the specified value or higher.
SOLUTION: High-frequency power subjected to first pulse modulation of 1/100000 or higher to 1/10 or lower of a prescribed frequency of 13.56 MHz or higher is applied to high-frequency power of this prescribed frequency of 13.5MHz or higher. That is, a substrate 4 to be treated is installed on a high-frequency electrode 5 in a vacuum container 12, the interior of the conainer 2 is set at the prescribed degree of vacuum by the operation of a valve 2 and the operation of an exhaust pump 1 and a prescribed amount of fluorine compound gas is introduced in the container 12 from bombs 7 by massflow controllers 6 via valves 2. Moreover, high-frequency power in a state that it is subjected to pulse modulation from a high-frequency power generation device 9 is applied to the electrode 5 and the substrate 4 to be treated is subjected to plasma treatment under this plasma atmosphere. Thereby, a metallic oxide on the solder bonded surface of the board 4 and the dirtness of the solder bonded surface are removed.



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09/889,838
102: ~~15~~, 17, 18, 19,
20, 21, 22, 23, 24
26, 29, 30, 31, 32
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16 Etch through mask / 25 0.3 μs [illegible] of sq wave. / 27 [illegible] 5-33 [illegible] / 28 [illegible] / 33 [illegible]

* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The gas of a fluorine system compound is introduced into inter-electrode [which was prepared in the vacuum housing / which counters] as a raw gas. In the plasma treatment method of performing the target plasma treatment to the soldered joint processing substrate which impressed power, was made carrying out plasma excitation and was installed in this electrode in this vacuum housing to the RF power of predetermined frequency 13.56MHz or more 1/100000 or more [of predetermined frequency] The plasma treatment method in the last process of the soldered joint processing performed by impressing the RF power which gave the 1st 1/10 or less pulse modulation.
[Claim 2] The plasma treatment method in the last process of soldered joint processing according to claim 1 of performing RF power impression which impressed the RF power of under the frequency of the 1st pulse modulation wave to the 1st pulse modulation in the aforementioned plasma treatment method, and gave the 2nd pulse modulation.
[Claim 3] The claim 1, the plasma treatment method of two publications which have on-off ratio T (%) in 0< T<100% of range in the plasma treatment method of the above 1 and the 2nd term.
[Claim 4] Plasma treatment equipment in the last process of soldered joint processing of having the RF power generator which a RF electrode and a grounding electrode are installed in a vacuum housing, replaces with the aforementioned RF generator in the RF plasma treatment equipment which has a RF generator, and consists of RF power amplification and a RF signal generator.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[The technical field to which invention belongs] this invention relates to the plasma treatment method of performing plasma treatment on the solder front face of a part joint which plasma-ized the raw gas and was prepared on the wiring substrate, and equipment, in the electronic-parts mounting process of a semiconductor field.
[Description of the Prior Art] Although the soldering process which mounts a semiconductor device in a printed-circuit board in a semiconductor field is needed, if a metallic oxide or a pollution field exists in the solder front face of the joint beforehand formed in the substrate, solder wettability will become inadequate at the time of soldering. Therefore, in order to guarantee the reliability of the physical electrical connection of mounting parts, order down stream processing special before and after a soldering process is required. That is, in order to maintain wettability, washing by chlorofluocarbon is performed for flux residue removal after use of the flux for removing a metallic oxide and a pollution field with pretreatment of a soldered joint, and soldering junction. However, since chlorofluocarbon, an volatile organic compost, etc. are towards toughening of regulations from a viewpoint of influence on environmental preservation or a human body, surface treatment which does not use flux, chlorofluocarbon, etc. is desired. Down stream processing (flux loess) which does not use flux for the soldering process of a printed-circuit board is an official announcement patent official report. It is indicated by common [5-500026] (example 1 of precedence). This technology is the technology which replaces the oxygen in a metallic oxide by the fluorine, and converts to a fluoride compound by exposing the metallic oxide currently formed in the solder pad front face on the wiring substrate which introduced fluorine system compound gas and was formed in a vacuum housing as pretreatment in the process which solders semiconductor parts to a printed-circuit board to the fluorine plasma excited by impression of RF power. As a result of having improved the wettability of solder by this plasma treatment, washing in a back process is made unnecessary at the same time it makes use of flux unnecessary at a last process. Thus, although it is indicated that it needs to be fluorine content plasma excited for this official report for removing a metallic oxide and a pollution field, it is not described concretely how fluorine content plasma is exposed to solder. The plasma treatment method that a soldering process order process can be skipped is learned by impressing the method of -, and RF power continuously, and exposing fluorine content plasma to solder. (Example 2 of precedence) However, since there were few electrons with the high energy only by impressing RF power continuously, there was a problem that there were also few fluorine radical amounts required for plasma treatment, and plasma treatment time became long.
[Problem(s) to be Solved by the Invention] this invention aims at shortening plasma treatment time in the plasma treatment and equipment which impress RF power, carry out plasma excitation of the fluorine system compound gas in view of the above-mentioned, and are exposed to solder.
[Means for Solving the Problem] this invention method and equipment impress the RF power which gave the 1st 1/100000 or more [of this predetermined frequency], and 1/10 or less pulse modulation to the RF power of the predetermined frequency beyond **13.56MHz.** Impress the RF power which gave the 2nd pulse modulation of a low from the frequency of the 1st pulse modulation of before **. Plasma treatment time can be shortened by these meanses. In addition, in a claim 1, the frequency of having set predetermined frequency to 13.56MHz or more is hard to take a low and matching (adjustment of an impedance) from it. Moreover, the opportunity of considered [in giving the 1st pulse modulation to the RF power of predetermined frequency / as 1/100000 or more frequency of predetermined frequency] of a low and the pulse modulation of power impression becomes less than 1/100000, and plasma treatment time becomes long. Moreover, when higher than 1/10, because the plasma which could not take matching but was stabilized was not able to be generated, it carried out to 1/10 or less. Furthermore, in the claim 3, when T is 0, plasma does not occur, but when T was 100%, a claim 1 and on-off ratio [of plasma according to claim 2] T (%) could be 0< T<100%, because it became the same as the example 2 of precedence. Moreover, by carrying out pulse modulation to the power wave impressed to a RF electrode, since the temperature of plasma gets cold, a rapid temperature rise is stopped. This has the advantage by which melting of the solder on a printed circuit board is barred in order to prevent deformation of a printed circuit board. Moreover, by performing ON and OFF control, since the density of a high-energy electron can be made to increase as shown in drawing 3 , many fluorine radicals required for the cleaning on the front face of solder can be generated, and plasma treatment time can be shortened.
[Embodiments of the Invention] Hereafter, the example of this invention is explained with reference to a drawing. Drawing 1 shows the outline composition of the parallel monotonous type RF plasma treatment equipment used for - operation of this invention method. 9 is a RF power generator, consists of a RF signal generator 11 and RF power amplification 10, and is connected to RF electrode 5 this minded the matching box 8. Since others are the same as that of well-known composition,

explanation is omitted. The RF power generator 9 gives the 1st pulse modulation to the continuation RF power 13.56MHz or more which is to the foundations of this application shown in drawing 2 (A) on 1/100000 or more [of this frequency], and 1/10 or less frequency, as shown in this drawing (B), and it is set up so that the RF power which repeats successively the ON time T1 and the OFF time T2 by the on-off ratio defined beforehand may be generated. Furthermore, on the frequency of under the pulse modulation frequency after [1st] giving the 1st pulse modulation of the above, the RF power generator 9 gives the 2nd pulse modulation, as shown in drawing 2 (C), and it is set up so that the RF power which repeats successively the ON time T3 and the OFF time T4 by the on-off ratio defined beforehand may be generated.

[Example] this invention method is enforced as follows. That is, the processing substrate 4 is installed on RF electrode 5 in a vacuum housing 12, the inside of this container 12 is made into a predetermined degree of vacuum by operation of a bulb 2 and operation of the exhaust air pump 1, and the raw gas (SF6, CF4, NF3, CHF3, SiF4 grade) of the specified quantity is introduced by the mass-flow controller 6 through a bulb 2 from a bomb 7. And the RF power in the state where pulse modulation was given to RF electrode 5 from the RF power generator 9 as aforementioned is impressed, the gas introduced by it is plasma-ized, and plasma treatment of the processing substrate 4 is carried out under this plasma. Thereby, a metallic oxide and dirt are removed.

Next, the example of processing which carried out plasma treatment with the equipment of drawing 1 is shown.

Example 1 of processing When plasma treatment only of the 1st pulse modulation is given and carried out Processing conditions 1 1) Processing substrate : A printed-circuit board 2) RF power : 300W 3) Predetermined frequency : 13.56MHz 4) The 1st modulation frequency : 68kHz 5) On-off ratio of the 1st modulation : 50% 6) Raw gas : SF6 gas 50sccm 7) Pressure : 150mTorr8 RF-electrode temperature : 30 degrees C Example 2 of processing When plasma treatment of the 1st and the 2nd pulse modulation is given and carried out Processing condition 2 1 processing substrate : [Printed-circuit board] 2) RF power : 300W 3 predetermined frequency : It is the 4 1st modulation frequency 13.56MHz : 68kHz 5) On-off ratio of the 1st modulation : 50% The 6 2nd modulation frequency : 1kHz 7) -- on-off ratio [of the 2nd modulation]: -- 50% 8) Raw gas : SF6 gas 50sccm 9) Pressure : 150mTorr 10 RF-electrode temperature : In the case of processing according to the example 2 of precedence as a result of comparing with the example 2 of precedence the plasma treatment time which makes a soldered joint possible in the examples 1 and 2 of 30-degree-C processing When the processing conditions 1 are applied for 5 minutes When the processing conditions 2 are applied for 1.5 minutes It was 1 minute. Thus, it became clear by using pulse modulation that are shifted to a high-energy field rather than the case where the electron in excitation plasma does not give pulse modulation as drawing 3 shows, and it contributes to generation of chemical active species, consequently plasma treatment time is shortened sharply. In addition, although the parallel monotonous type was used as equipment in this example, this invention is not limited to this.

[Effect of the Invention] As mentioned above, equipment can be offered, while according to this invention the process before and behind a soldered joint can be skipped and plasma treatment time can be shortened.

[Translation done.]

Patent Abstracts of Japan

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APPLICANT : NISSIN ELECTRIC CO LTD;

INVENTOR : KUWABARA SO;

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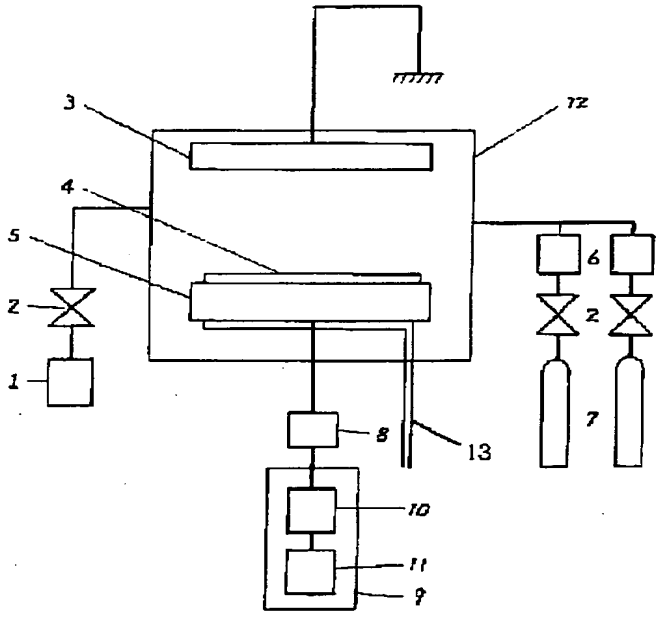
TITLE : PLASMA TREATMENT IN PRECEDING PROCESS FOR SOLDER BONDING TREAMENTG AND DEVICE



ABSTRACT : PROBLEM TO BE SOLVED: To remove a metallic oxide on the solder bonded surface of a substrate to be treated and the dirt on the solder bonded surface in a short time by a method wherein high-frequency power subjected to first pulse modulation of 1/100000 or higher to 1/10 or lower of a prescribed frequency of a specified value or higher is applied to high-frequency power of this prescribed frequency of the specified value or higher.

SOLUTION: High-frequency power subjected to first pulse modulation of 1/100000 or higher to 1/10 or lower of a prescribed frequency of 13.56 MHz or higher is applied to high-frequency power of this prescribed frequency of 13.5MHz or higher. That is, a substrate 4 to be treated is installed on a high-frequency electrode 5 in a vacuum container 12, the interior of the conainer 2 is set at the prescribed degree of vacuum by the operation of a valve 2 and the operation of an exhaust pump 1 and a prescribed amount of fluorine compound gas is introduced in the container 12 from bombs 7 by massflow controllers 6 via valves 2. Moreover, high-frequency power in a state that it is subjected to pulse modulation from a high-frequency power generation device 9 is applied to the electrode 5 and the substrate 4 to be treated is subjected to plasma treatment under this plasma atmosphere. Thereby, a metallic oxide on the solder bonded surface of the board 4 and the dirtness of the solder bonded surface are removed.

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						Ｋ
Ｃ２３Ｆ	4/00			Ｃ２３Ｆ	4/00	Ａ
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(71)出願人　000003942
日新電機株式会社
京都府京都市右京区梅津高畝町47番地

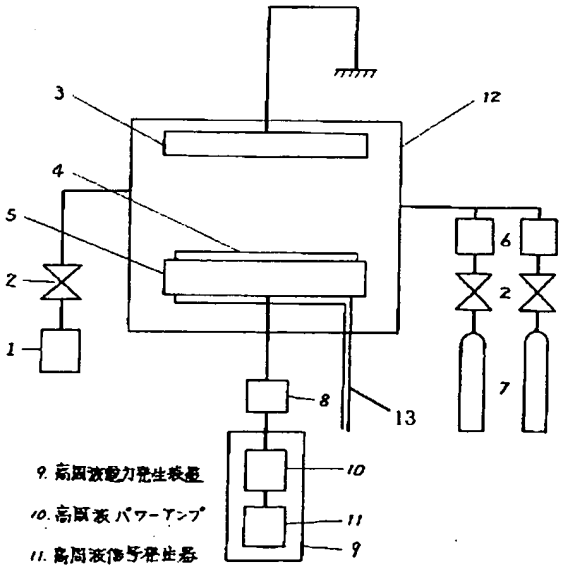
(72)発明者　坂本　浩道
京都市右京区梅津高畝町47番地日新電機株式会社内

(72)発明者　中東　孝浩
京都市右京区梅津高畝町47番地日新電機株式会社内

(72)発明者　桑原　創
京都市右京区梅津高畝町47番地日新電機株式会社内

(54)【発明の名称】　半田接合処理の前工程におけるプラズマ処理方法及び装置

(57)【要約】
【課題】半田接合面の金属酸化物、汚れを短時間で除去し、半田接合の前後工程を不要にする。
【解決手段】真空容器内に設けた対向する電極間に、所定真空下で処理ガスを導入して高周波電力を印加し、励起させたプラズマのもとで該真空容器内の該電極に設置された処理基板に半田接合を可能とするプラズマ処理を行うプラズマ処理方法及び装置において、該電極に印加するプラズマ高周波電力を所定周波数の高周波電力に第１及び第２のパルス変調を行った電力を印加する。



【特許請求の範囲】

【請求項１】　真空容器内に設けた対向する電極間に処理ガスとしてフッ素系化合物のガスを導入し、電力を印加してプラズマ励起させ、該真空容器内の該電極に設置された半田接合処理基板に目的とするプラズマ処理を行うプラズマ処理方法において１３．５６ＭＨｚ以上の所定周波数の高周波電力に所定周波数の１／１００００以上、１／１０以下の第１のパルス変調を施した高周波電力を印加することで行う半田接合処理の前工程におけるプラズマ処理方法。

【請求項２】　前記プラズマ処理方法において第１のパルス変調に第１のパルス変調波の周波数未満の高周波電力を印加し第２のパルス変調を施した高周波電力印加を行う請求項１記載の半田接合処理の前工程におけるプラズマ処理方法。

【請求項３】　前記１、２項のプラズマ処理方法において、オンオフ比Ｔ（％）が０＜Ｔ＜１００％の範囲にある請求項１、２記載のプラズマ処理方法。

【請求項４】　真空容器内に高周波電極と接地電極が設置され、高周波電源を有する高周波プラズマ処理装置において、前記高周波電源に代えて高周波パワーアンプと高周波信号発生器からなる高周波電力発生装置を有する半田接合処理の前工程におけるプラズマ処理装置。

【発明の詳細な説明】

【発明の属する技術分野】本発明は、半導体分野の電子部品実装工程において、処理ガスをプラズマ化し配線基板上に設けられた部品接合部の半田表面にプラズマ処理を行うプラズマ処理方法、及び装置に関する。

【従来技術】半導体分野において半導体デバイスをプリント配線基板に実装する半田付け工程が必要になるが、基板にあらかじめ形成された接合部の半田表面に金属酸化物、もしくは汚染領域が存在すると半田付け時に半田濡れ性が不十分になる。そのため実装部品の物理的電気接続の信頼性を保証するために、半田付け工程前後に特別な前後処理工程が必要である。すなわち、濡れ性を維持するために半田接合の前処理に金属酸化物及び汚染領域を除去するためのフラックスの使用、そして半田付け接合後にフラックス残さ除去のために例えばフロンによる洗浄が行われている。しかし、環境保全や人体への影響の観点からフロン類、揮発性有機合成物などが規制強化の方向にあるため、フラックス、フロン等を使用しない表面処理が望まれている。プリント配線基板の半田付け工程にフラックスを用いない（フラックスレス）処理工程は公表特許公報　平５－５００２６に開示されている（先行例１）。この技術は、半導体部品をプリント配線基板に半田付けする工程において前処理として真空容器内にフッ素系化合物ガスを導入し、形成された配線基板上の半田パッド表面に形成されている金属酸化物を高周波電力の印加によって励起されたフッ素プラズマに晒すことにより、金属酸化物中の酸素をフッ素に置換してフッ化化合物へ転化する技術である。このプラズマ処理によって半田の濡れ性を改善した結果、前工程でフラックスの使用を不要にすると同時に後工程における洗浄を不要にしたものである。このように本公報には金属酸化物及び汚染領域を除去するためのフッ素含有プラズマ励起が必要であるとは記載されてあるが、フッ素含有プラズマをどのように半田に晒すかについて具体的に記述されていない。一方、高周波電力を連続的に印加してフッ素含有プラズマを半田に晒すことによって半田付け工程の前後工程を省略することができるプラズマ処理方法が知られている。（先行例２）しかし、高周波電力を連続的に印加するだけでは、高エネルギーをもった電子が少ないためプラズマ処理に必要なフッ素ラジカル量も少なく、プラズマ処理時間が長くなるという問題があった。

【発明が解決しようとする課題】本発明は前述に鑑み、高周波電力を印加しフッ素系化合物ガスをプラズマ励起して半田に晒すプラズマ処理及び装置においてプラズマ処理時間を短縮することを目的とする。

【課題を解決するための手段】本発明方法及び装置は、①１３．５６ＭＨｚ以上の所定周波数の高周波電力に、この所定周波数の１／１００００以上、１／１０以下の第１のパルス変調を施した高周波電力を印加する。②前①の第１のパルス変調の周波数より低い第２のパルス変調を施した高周波電力を印加する。これらの手段によってプラズマ処理時間を短縮することができる。なお、請求項１において、所定周波数を１３．５６ＭＨｚ以上としたのは周波数がそれより低いとマッチング（インピーダンスの整合）が取り難いためである。また、所定周波数の高周波電力に、第１のパルス変調を施すことにおいて所定周波数の１／１００００以上の周波数としたのは１／１００００より低いと、電力印加のパルス変調の機会が少なくなりプラズマ処理時間が長くなる。また、１／１０以下としたのは１／１０より高いとマッチングがとれず安定したプラズマを発生させることが出来ないためである。さらに、請求項３において請求項１及び請求項２記載のプラズマのオンオフ比Ｔ（％）が０＜Ｔ＜１００％としたのはＴが０の場合はプラズマが発生せず、Ｔが１００％の場合は先行例２と同じになるためである。また、高周波電極に印加される電力波形にパルス変調を実施することにより、プラズマの温度が冷えるため急激な温度上昇が抑えられる。これはプリント基板の変形を防ぐためだけではなく、プリント基板上の半田の溶融が妨げられる利点を有する。また、オン、オフ制御を行うことで、図３に示すように高エネルギー電子の密度を増加させることが出来るため、半田表面の清浄化に必要なフッ素ラジカルを多く生成することができ、プラズマ処理時間を短縮することができる。

【発明の実施の形態】以下、本発明の実施例を図面を参照して説明する。図１は本発明方法の一実施に用いる平

行平板型高周波プラズマ処理装置の概略構成を示している。9は高周波電力発生装置であり、高周波信号発生器11及び高周波パワーアンプ10よりなり、これがマッチングボックス8を介してた高周波電極5に接続される。その他は公知の構成と同様であるので説明を省略する。高周波電力発生装置9は、図2（A）に示す本願の基本となる13．56MHz以上の連続高周波電力に同図（B）に示すように該周波数の1／100000以上、1／10以下の周波数で第1のパルス変調を施し、予め定めたオンオフ比でオン時間T1、オフ時間T2を順次繰り返す高周波電力を発生するように設定される。さらに、高周波電力発生装置9は、前記第1のパルス変調を施した後第1のパルス変調周波数未満の周波数で第2のパルス変調を図2（C）に示すように施し、予め定めたオンオフ比でオン時間T3、オフ時間T4を順次繰り返す高周波電力を発生するように設定される。

【実施例】本発明方法は次のように実施される。すなわち、処理基板4が真空容器12内の高周波電極5上に設置され、該容器12内がバルブ2の操作と排気ポンプ1の運転にて所定真空度とされ、ボンベ7からバルブ2を介してマスフローコントローラ6により所定量の処理ガス（SF6、CF4、NF3、CHF3、SiF4等）が導入される。そして高周波電極5に高周波電力発生装置9から前記のとおりパルス変調を施した状態の高周波電力が印加され、それによって導入されたガスがプラズマ化され、このプラズマの下で処理基板4はプラズマ処理される。これにより金属酸化物及び汚れは除去される。次に図1の装置によりプラズマ処理した処理例を示す。

処理例1　　第1のパルス変調だけを施してプラズマ処理した場合

処理条件1

1）処理基板	：プリント配線基板
2）高周波電力	：300W
3）所定周波数	：13．56MHz
4）第1の変調周波数	：68kHz
5）第1の変調のオンオフ比	：50％
6）処理ガス	：SF6ガス　50sccm
7）圧力	：150mTorr
8）高周波電極温度	：30℃

処理例2　　第1、第2のパルス変調を施してプラズマ処理した場合

処理条件2

1）処理基板	：プリント配線基板
2）高周波電力	：300W
3）所定周波数	：13．56MHz
4）第1の変調周波数	：68KHz
5）第1の変調のオンオフ比	：50％
6）第2の変調周波数	：1KHz
7）第2の変調のオンオフ比	：50％
8）処理ガス	：SF6ガス　50sccm
9）圧力	：150mTorr
10）高周波電極温度	：30℃

処理例1、2において半田接合を可能にするプラズマ処理時間を先行例2と比較した結果、

先行例2による処理の場合　　5分

処理条件1を適用した場合　　1．5分

処理条件2を適用した場合　　1分

であった。このようにパルス変調を用いることにより図3で示すように励起プラズマ中の電子がパルス変調を施さない場合よりも高エネルギー領域にシフトされ、それが化学的活性種の生成に寄与し、その結果、プラズマ処理時間が大幅に短縮されることが明らかになった。なお、本実施例では装置として平行平板型を用いたが、本発明はこれに限定されるものではない。

合前後の工程を省くことができ、かつプラズマ処理時間を短縮することができると同時に、装置を提供することができる

【図面の簡単な説明】

【図1】本発明の実施に用いた平行平板型の高周波プラズマ処理装置の概略構成図。

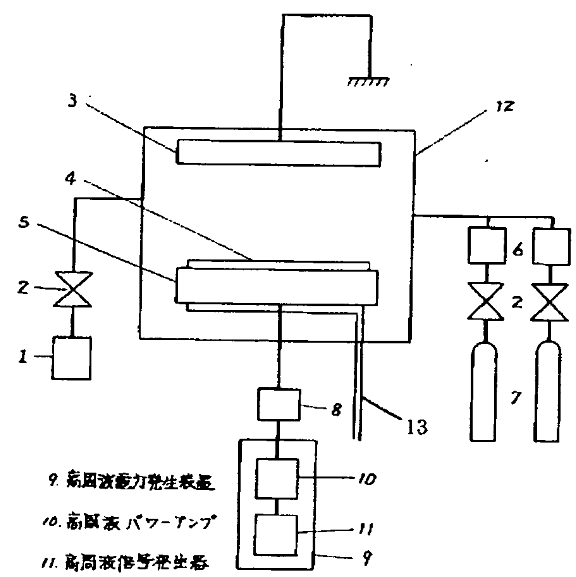
【図2（A）】本発明の基本となる13．56MHz以上の従来のプラズマ生成をさせた場合の電力波形図。

【図2（B）（C）】本発明に適用するパルス変調されたプラズマを生成させた場合の電力波形図。

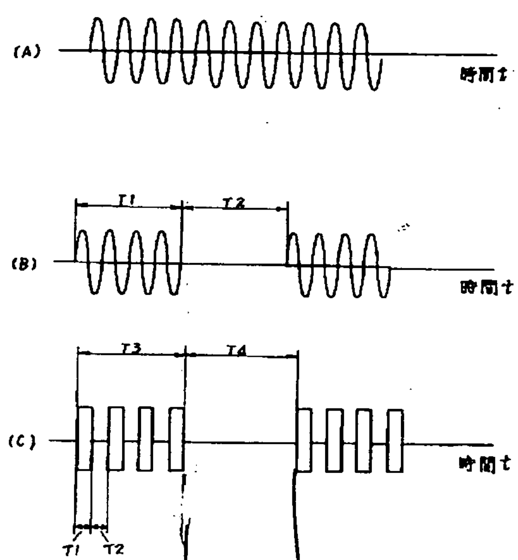
【図3】各プラズマ処理の場合の電子数と電子エネルギーの関係を示す図。

図１の符号の説明
1．排気ポンプ
2．バルブ
3．接地電極
4．半田接合処理基板
5．高周波電極
6．マスフローコントローラ
7．プロセスガスボンベ
8．マッチングボックス
9．高周波電力発生装置
10．高周波パワーアンプ
11．高周波信号発生器
12．真空容器
13．冷却機構

【図1】



【図2】



4:10

$\frac{4}{14} \times 100 =$ duty cycle $\times$ 300W = avg W

【図3】